

## Chapter 19

### Environmentally tough coral species as candidates for aquarium culture

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#### ABSTRACT

The Arabian Gulf is a relatively small body of water connected to the Indian Ocean via the narrow Straits of Hormuz. Kuwait lies on the north – western shore of the Arabian gulf at a latitude of 29° N placing it over 500 km north of the typical coral reef zone.

There is a clear gradient of species diversity for both corals and fish from the mouth of the Gulf where the diversity is highest, to its northern reaches with the lowest diversity. A total of 35 scleractinian coral species, from 12 families, have been recorded in Kuwait waters and of these 27 species are hermatypic (reef building) and eight species are ahermatypic (non reef building) corals.

In Kuwait the water temperatures can reach 35 °C in summer and drop to 11.5 °C in winter. The salinity of the Kuwait waters varies from 38 ppt to 42.4 ppt. These two major extreme factors combine with other minor factors (turbidity, sedimentation, natural hydrocarbon presence) to limit coral diversity in Kuwait and the Arabian Gulf waters.

However, the corals that do thrive in this area are some of the most environmentally tolerant in the world. This makes them of special scientific interest, and some of them are ideal candidates for culture in aquarium environments.

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#### INTRODUCTION

Coral communities around the world develop best in the tropical waters generally between latitudes 23.5° N and 23.5° S. These waters are characterized by being relatively stable with low turbidity, temperature between 21 °C and 25 °C and a salinity of approximately 35 ‰.

Kuwaiti waters, in the northern part of the Arabian Gulf, show more extreme environmental circumstances, but still harbour a number of scleractinian coral species.

Their distribution was studied, and compared to the distribution of major environmental factors.

#### DESCRIPTION OF THE STUDY AREA

The Arabian Gulf is a relatively small body of water connected to the Indian Ocean via the narrow Straits of Hormouz (see Figure 1).

It is also a relatively young body of water, only being flooded since the last ice age 20,000 years ago (Sheppard, 1993). The Gulf is generally

shallow with the deepest sections >100 m in the South near the Straits of Hormouz (Al-Yamani *et al.*, 2004). Being shallow allows the prevailing winds to cause good water column mixing and thus there is no real thermocline.

The environmental conditions of the Gulf are heavily influenced by the surrounding deserts and are thus influenced by considerable seasonal variations. The extremely high solar radiation experienced during the summer months causes huge evaporation from the sea. Coupled with relatively low rainfall and low fresh water inflow from limited numbers of rivers the salinity is generally 20-25 ‰ higher than typical Ocean waters (Carpenter *et al.*, 1997). The salinity does not show a large seasonal variation (see Figure 2) with levels between 36 ‰ and 42 ‰.

Air temperatures are seasonally extreme with winter temperatures falling below freezing

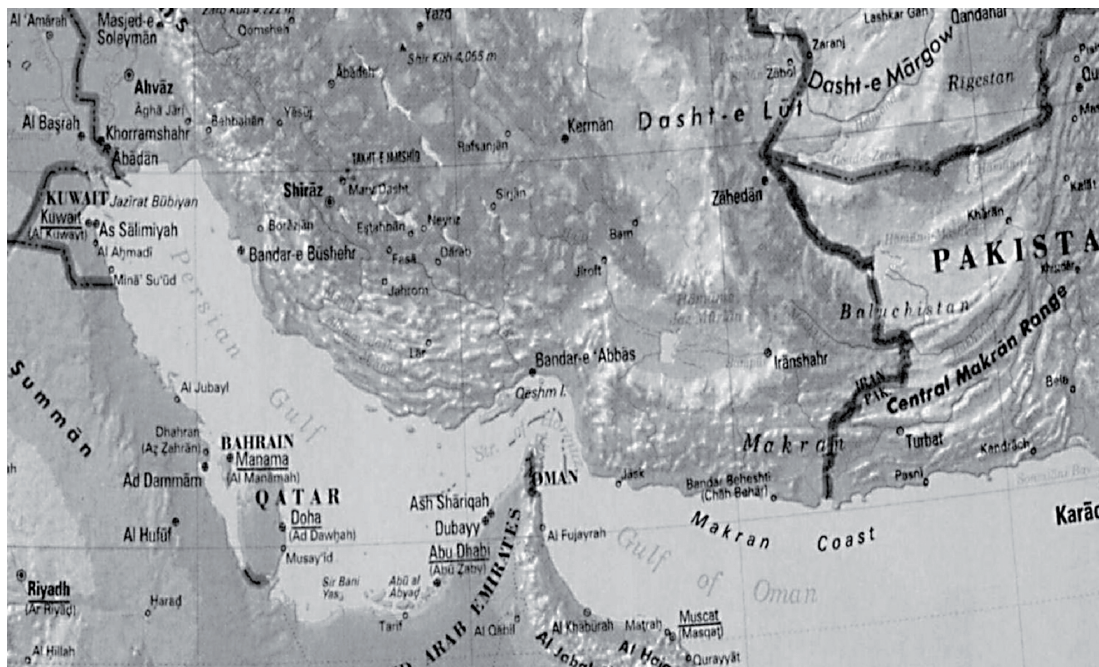


Figure 1: Map of the Arabian Gulf

and summer temperatures exceeding 50 °C. As the Gulf is relatively shallow the extreme seasonal air temperatures affect the seawater temperature to a great degree (see Figure 2). The seawater during the hot summer months can reach temperature of above 35 °C. The winter seawater temperatures can fall to 11.5 °C. The season variation is approximately 23.5 °C which can cause stress to any resident animal.

The majority of Kuwait's undersea substrate consists of fine grained sediments (mud and sandy mud) (Al-Ghadban and Price, 2002). The deposition of these sediments is attributed to the counter clockwise water circulation in the Gulf and the influence of rivers sediments. The relatively low energy sea conditions found in the north-western area of the Gulf allows for the suspended sediments to settle out.

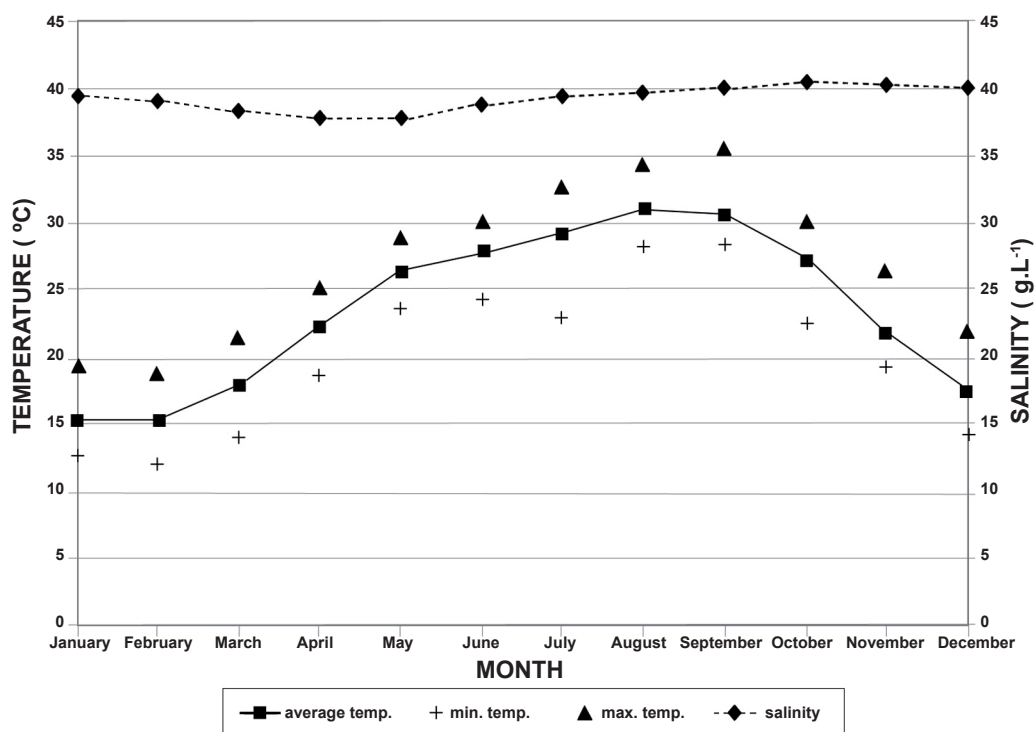


Figure 2: Monthly average seawater temperature and salinity in Kuwait. (Data from Kuwait Institute of Scientific Research, Mariculture and Fisheries Department, 1983-2004, Dr. J.M. Bishop, pers.com.)

Sedimentation rates in Kuwait vary according to topographical position. The closer to the mouth of the northern rivers the higher the rates. Kuwait Bay in the north of the country has high annual sedimentation levels of 1-2  $\text{cm.y}^{-1}$  compared to the offshore areas around the islands of 1  $\text{mm.y}^{-1}$  (Al-Ghadban, pers. com.). There are a number of natural oil seeps in Kuwait waters and this has led to background levels of petroleum hydrocarbons in sediments of between 13.7 and 375  $\mu\text{g.g}^{-1}$ . These values are classified as being from unpolluted to heavily polluted sediments. The higher levels will have an effect on the distribution and survival of corals (Literathy *et al.*, 2002).

### LIMITING FACTORS TO CORAL GROWTH

The extreme seasonal temperatures experienced in Kuwait waters coupled with the high salinity levels are considered the major environmental factors limiting the number of coral species found in Kuwait.

Temperature is one of the most important limiting environmental factors for the survival of corals. Usually cold water is the limiting and thus latitudinal restriction factor for corals (Coles and Fadlallah, 1991). Low temperatures result in 'bleaching' and eventually death of the corals and water below 18°C is considered



Figure 3: Map of Kuwait showing relative position in Arabian Gulf. Coral Islands and areas of coral growth are illustrated. Kuwait is situated at 29° N, over 500 km north of the typical coral reef zone between 23.5° N and 23.5° S.

Table 1: Number of Reef building coral species found in the Arabian Gulf and the Indo Pacific Region.

Indo Pacific Region	Gulf of Oman	Bahrain & Saudi Arabia	Kuwait
500	53	38	29

too cold to allow long term coral survival and growth (Coles, 1988; Coles and Fadlallah, 1991; Hodgson and Carpenter, 1995).

### DISTRIBUTION OF CORAL SPECIES

As one moves geographically further north from the Gulf of Oman the number of reef building coral species is reduced with Kuwait having the lowest species count of 29. This low species count is mostly due to the temperature and salinity factors mentioned. However, other factors such as turbidity, sedimentation and natural hydrocarbon presence also add to the factors that limit the coral species in Kuwait (Carpenter *et al.*, 1997; Hodgson and Carpenter, 1995). The corals of Kuwait are generally restricted to the southern areas and include the three coral

sand islands (cays), platform reefs, patch reefs and the fringing reef along the southern coast (see Figure 3). The corals are limited to depths <15 m with the best growth and diversity in water <10 m. The three islands have the best developed reefs. The 35 recorded species of Scleractinian corals from 12 families are presented in Table 2 with 27 species being hermatypic (reef building) and eight species ahermatypic. There is one endemic species found in the Gulf: *Acropora arabensis* (Carpenter *et al.*, 1997; Harrison, pers. com.).

Table 3 shows the species of corals that have been displayed at the Scientific Center in Kuwait for the past seven years. All of the specimens of all of the species displayed have survived over this period. There is no data on coral growth in the displays.

Table 2: Scleractinian corals of Kuwait.

Family	Species	Family	Species
Pocilloporidae	<i>Stylophora pistillata</i>	Acroporidae	<i>Acropora clathrata</i>
	<i>Madracis kirbyi</i>		<i>Acropora arabensis</i>
Poritidae	<i>Porites harrisoni</i>	Caryophylliidae	<i>Polycyathus marigondoni</i> *
	<i>Porites lutea</i>		<i>Paracyathus stokesi</i> *
	<i>Goniopora lobata</i>		<i>Heterocyathus</i>
Siderastreidae	<i>Siderastrea savignyana</i>		<i>aequicostatus</i> **
	<i>Anomastrea irregularis</i>	Dendrophylliidae	<i>Turbinaria peltata</i>
	<i>Psammocora superficialis</i>		<i>Turbinaria reniformis</i>
	<i>Psammocora contigua</i>		<i>Heteropsammia cochlea</i> **
	<i>Coscinaraea columna</i>		<i>Dendrophyllia gracilis</i> *
Agariciidae	<i>Pavona explanulata</i>		<i>Tubastraea coccinea</i> *
	<i>Pavona decussata</i>		<i>Tubastraea tagusensis</i> *
Merulinidae	<i>Hydnophora exesa</i>	Mussidae	<i>Acanthastrea echinata</i>
Faviidae	<i>Favia speciosa</i>		<i>Acanthastrea maxima</i>
	<i>Favia pallida</i>	Faviidae	<i>Cyphastrea microphthalma</i>
	<i>Favites pentagona</i>		<i>Cyphastrea serailia</i>
	<i>Platygyra daedalea</i>	Rhizangiidae	<i>Culicia tenella</i> *
	<i>Plesiastrea versipora</i>		
	<i>Leptastrea transversa</i>		

\* ahermatypic coral species

\*\* might be considered ahermatypic as they are solitary and slow growing species

Data from Carpenter *et al.* (1997) with modifications to species names by Veron (2000)



Table 3: Coral species displayed at The Scientific Center Aquarium.

Family	Species
Dendrophylliidae	<i>Turbinaria peltata</i>
Acroporidae	<i>Acropora arabensis</i>
Agariciidae	<i>Pavona explanulata</i>
Dendrophylliidae	<i>Dendrophyllia gracilis</i>
Poritidae	<i>Porites</i> sp.
Faviidae	<i>Favia pallida</i>
Pocilloporidae	<i>Stylophora pistillata</i>

## CONCLUSIONS

The harsh and extreme marine environmental conditions in Kuwait are near the limits for most coral species. The high and low temperatures, the high salinities, high sedimentation rates, high turbidity because of sediment loads and natural hydrocarbon seeps all act as stressors that limit the number of coral species found in the area. The species that do occur in the area are relatively 'tough' and show a remarkable resilience for the varied conditions experienced.

Kuwait coral species are of international scientific interest because they flourish in environmental conditions previously believed to be too extreme for corals to survive. Some of these species are ideal candidates for culture in aquarium environments as they are relatively tolerant to sub optimal conditions.

The Scientific Center is willing and able to assist any other Aquarium and/or Research facility in the collection, transport and culture of the species mentioned in Table 2. Please contact the author for further assistance and information.

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